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DESIGN AND TESTING OF THE H-53, 450 GALLON AUXILIARY FUEL TANK CONTAINER

AIR FORCE PACKAGING EVALUATION AGENCY

JUNE 1976

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DESIGN AND TESTING OF THE H-53, 450-GALLON AUXILIARY FUEL TANK CONTAINER

HQ AFLC/DSP
AIR FORCE PACKAGING EVALUATION AGENCY
WRIGHT-PATTERSON AFB OH 45433

JUNE 1976

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HQ TAC/LGT has proposed, through WR-ALC/DSP, a container design project to the Air Force Packaging Evaluation Agency (AFPEA) relative to development of a transport device/container for auxiliary fuel tanks used with the H-53 helicopter. The container(s) are essential to rapid deployment of the H-53 in contingency response situations. Since the helicopter cannot be ferried worldwide, and still meet planning/timing considerations, the H-53 is partially disassembled and moved via the C-5 Galaxy aircraft. The helicopter, however, will

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20. Abstract (Continued)

not fit into the C-5 with its auxiliary fuel tanks attached; also, to be air-shippable, these tanks must be purged of jet fuel fumes in accordance with AFM 71-4. This is a process normally involving 72 hours. The AFPEA has developed a sturdy handling device/container that will allow the H-53 tanks to be safely moved when partially filled with jet fuel. This container has been subjected to strenuous vibration and mechanical handling tests, along with the fit and function tests, and as a system it is fully qualified to satisfy the design criteria. The current cost of this container is well under $350 including labor and materials.

NOTICE

ABSTRACT

HQ TAC/LGT has proposed, through WR-ALC/DSP, a container design project to the Air Force Packaging Evaluation Agency (AFPEA) relative to development of a transport device/container for auxiliary fuel tanks used with the H-53 helicopter. The container(s) are essential to rapid deployment of the H-53 in contingency response situations.. Since the helicopter cannot be ferried worldwide, and still meet planning/timing considerations, the H-53 is partially disassembled and moved via the C-5 Galaxy aircraft. The helicopter, however, will not fit into the C-5 with its auxiliary fuel tanks attached; also, to be air-shippable, these tanks must be purged of jet fuel fumes in accordance with AFR 71-4. This is a process normally involving 72 hours. The AFPEA has developed a sturdy handling device/container that will allow the H-53 tanks to be safely moved when partially filled with jet fuel. This container has been subjected to strenuous vibration and mechanical handling tests, along with the fit and function tests, and as a system, it is fully qualified to satisfy the design criteria. The current cost of this container is well under $350 including labor and materials. The cost, therefore, becomes another benefit as the potential users of this container had originally estimated that in order to perform all the functions needed, a more costly container would have to be developed.

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INTRODUCTION

The Air Force Packaging Evaluation Agency (AFPEA) has been tasked by TAC through WR-ALC/DSP to develop a shipping fixture capable of supporting a 450-gallon H-53 external auxiliary fuel tank when 3/4 full of JP-4 fuel. It was immediately obvious that the usual method of supporting empty fuel tanks within a container at the hard spots would not be adequate. The design would have to provide enough support to the tank with a bearing area large enough to lower the static stress so that reliability would be maximized.

PROCEDURE

1. The general design was decided early in the program and modifications have been derived from it. Basically, the shipping fixture was projected to have a metal undercarriage running at a minimum, the distance between the tank hard spots. Rigid polyurethane foam would completely encapsulate this metal structure and be form fitted to the tank as shown in Figure 1, page 5.

2. The maximum load to be supported was 3/4 of the total fuel tank capacity which is 442 gallons. The density of JP-4 fuel is 6.5 lbs/gal and therefore, the weight of fuel needed would be 2057.25 lbs. For test purposes and reasons of safety, this weight was approximated with 242 gallons of water.

3. The various prototypes designed are as follows:

a. The TPO container used as the internal structure for the foam-in-place process with the fuel tank totally encapsulated to a point just below the fuel tank horizontal centerline. From visual inspection, this arrangement did not seem to provide enough reliability to be used.

b. A slotted angle internal structure substituted for the TPO container as described in a. above. This arrangement is shown in Figure 2, page 6.

c. A slotted angle/foam-in-place assembly supporting the area between the tank hard-spots as shown in Figure 1, page 5.

d. A slotted angle/foam-in-place assembly similar to the c. version with diagonal supports added for strength. This was considered to be the optimum design based on total cost and performance reliability. This handling device is shown in Figure 3, page 7, and Figure 4, page 8.

TESTING

The container shown in Figure 4, page 8 was subjected to vibration and mechanical handling tests performed in accordance with the procedures established in Federal Test Methods Standard 101.

1. Vibration (Repetitive Shock) Test. Method 5019 of FTMS 101B outlines the procedure to be followed in conducting this test. This procedure was altered slightly in that the container was secured to the table top using restraining devices similar to those used in the C-5 aircraft. Since this is a highly specialized container, and the mode of travel should never vary, the deviation in test procedure is justified.

The fuel tank was placed in the container and filled with water to simulate 330 gallon of JP-4 fuel. The fuel tank was then secured to the container by means of hold-down (cargo-type) straps and placed in the center of the vibration table. The container was restrained to the table in a manner similar to that used aboard the aircraft.

The container was then vibrated at 4.5 Hz for two hours with table displacement being 1" double amplitude. There was no visible damage to the tank and the 3/4 full fuel tank had no damaging effect on the container.

2. Mechanical Handling Test. This portion of the test plan dealt with the actions involved in disconnecting the fuel tank from the helicopter, loading it aboard the C-5 aircraft, off-loading the fuel tank at destination, and then connecting it to the helicopter. Method 5016 of FTMS 101B was the test used to simulate the ground travel of the the fuel tank, still with the simulated 3/4 full of fuel in the container. The AFPEA test course was set up using 8' lengths of nominal 1 x 4's as specified in Method 5016 procedure of FTMS 101B. This test was performed twice and showed the container and fuel tank to be a stable load that was not affected by this test. The loaded container was then transported by forklift truck at a horizontal angle of about 5°. The first run was with the forward bottom end lower than the aft bottom. Testing in this configuration created no problems. The second run was a reverse of the first with the aft bottom end lower than the forward bottom. On this run there was a noticeable unbalancing of the container causing the aft end to touch the ground. When this happened, the container was set down and the fluid level allowed to stabilize. This required approximately 15 seconds. The container could then safely be lifted and transported again until the load became unbalanced. On this type of grade slope,

at least 75 foot of forward progress was made before a tank stabilization had to be made.

Connecting/Disconnecting the fuel tank to helicopter was first simulated by raising the loaded fuel tank and container by a forklift truck to heights of 1, 2, and 3 feet and holding at each height for at least 5 minutes. Again, there was no problem encountered and the load remained stable at all times.

3. Actual Tank-Helicopter-Container Fit. This was the final test conducted and consisted of taking an empty container and transporting it to a H-53 helicopter. The 450-gallon fuel tanks were attached to the helicopter for this test. The empty container was then positioned by forklift exactly under one of the fuel tanks and then raised to make contact with the fuel tank, thus simulating the unloading of an actual tank on a helicopter. The fit was very good but to provide greater clearance for the stand-pipe on the helicopter the height of container was lowered and the side wall angle was increased. These changes will not affect the static or dynamic performance qualities of the container and therefore a retest was not felt necessary.

DISCUSSION

1. The container developed by the AFPEA has been designed to accommodate weights in excess of the 3/4 full of JP-4 fuel for the H-53, 450-gallon fuel tank. It has proved to be not only an effective shipping device as requested by WR-ALC and TAC, but also as a handling device for connecting/disconnecting the tanks from the H-53 helicopter. The cost estimated to be under $350 makes the use of this specialized container very practical, as does using a common 4,000 lb forklift.

2. Due to the quantity of fuel to be shipped in the fuel tank at any one time being an unknown, it is not possible to mark the exact center of gravity of the tank, especially since the tank is situated at a 5° nose-down incline. Figure 4, page 8 shows the center of gravity (CG) for a 3/4 full fuel tank and for an empty tank. The tank is adjustable in the container so that for any fuel level from 0 to 330-gallon the CG can be aligned with the center of lift of the container. This will provide a stable load, at any time, and if a loaded container goes from a stable to an unstable condition while being ground transported the container can be set on the ground to stabilize. If this doesn't solve the problem, the tank may have to be shifted either fore or aft. This will not affect the fit on the helicopter.

3. The container/handling device is fabricated using 2 pcf rigid polyurethane foam, poured over the slotted angle/plywood undercarriage as shown in Figure 3, page 7. The forming jig used to contain the foam while it was rising and during cure time is shown in Figure 5, page 9 and in Figures 7 and 8, page 11. Complete production of the container/handling device, from assembly of the forming jig to final container marking, is detailed in the assembly procedure shown in Figure 6, page 10. The final prototype is shown in Figures 9 and 10, page 12. Note that in these figures, a 4-wheeled cart used for in-house mobility is shown.

4. In order for this assembly, up to 3/4 full of fuel in tank, to be shipped aboard any aircraft a waiver to AFR 71-4 will have to be obtained. The Technical Order for the H-53 helicopter should be changed to reflect the requirement for sealing this tank for shipment and to note the need for a waiver to AFR 71-4.

SHIPPING AND HANDLING DEVICE

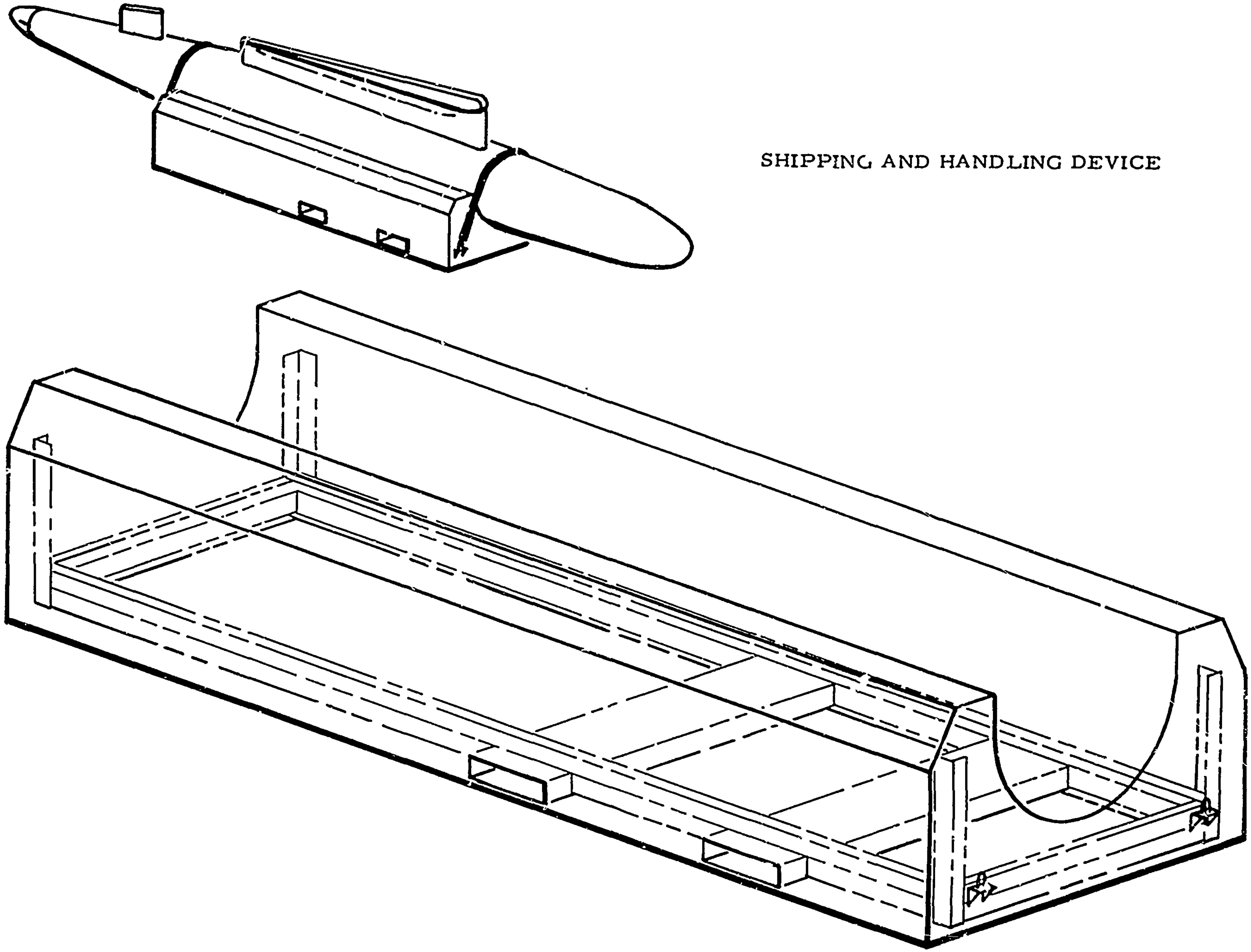


Figure 1

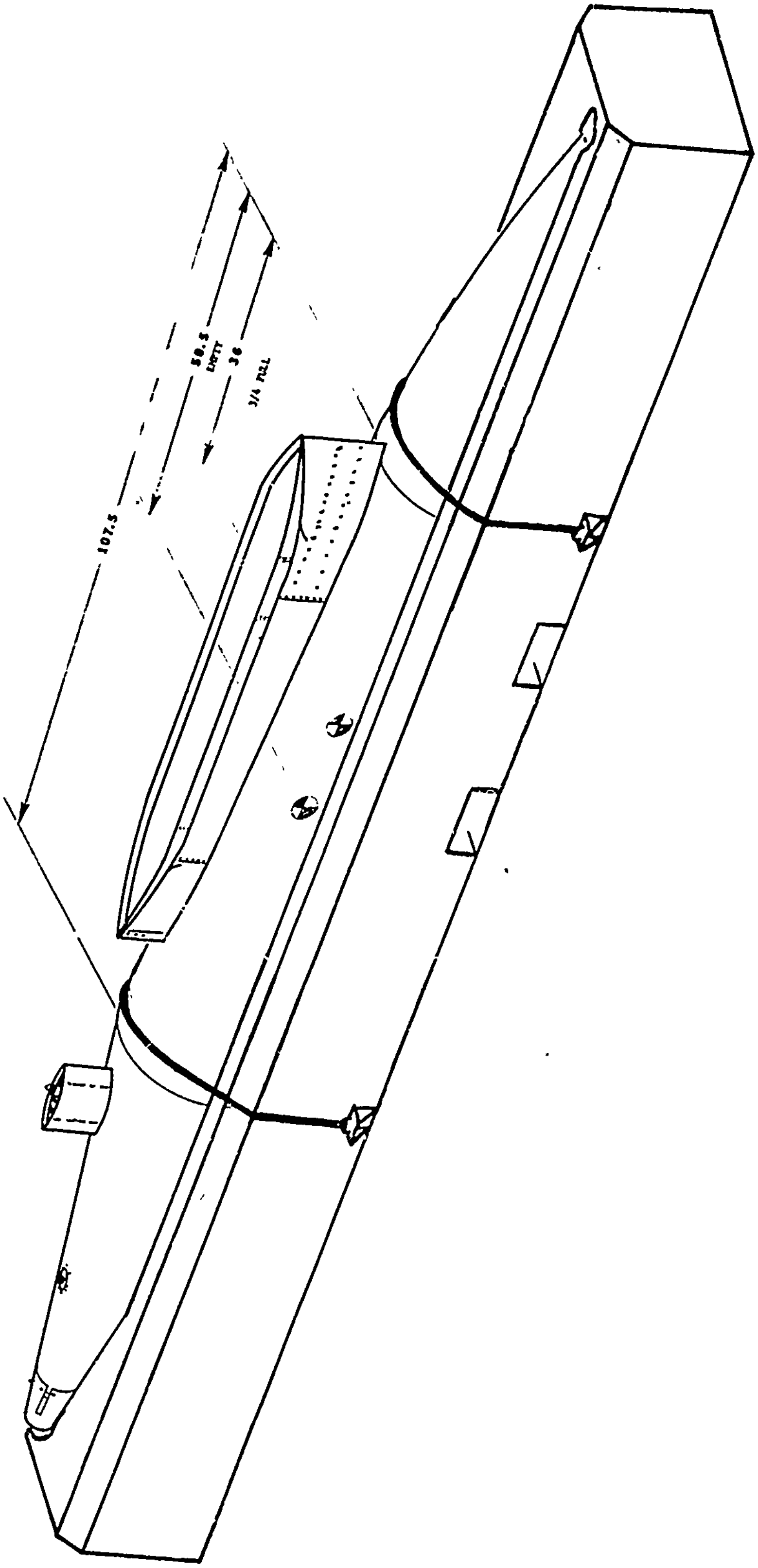
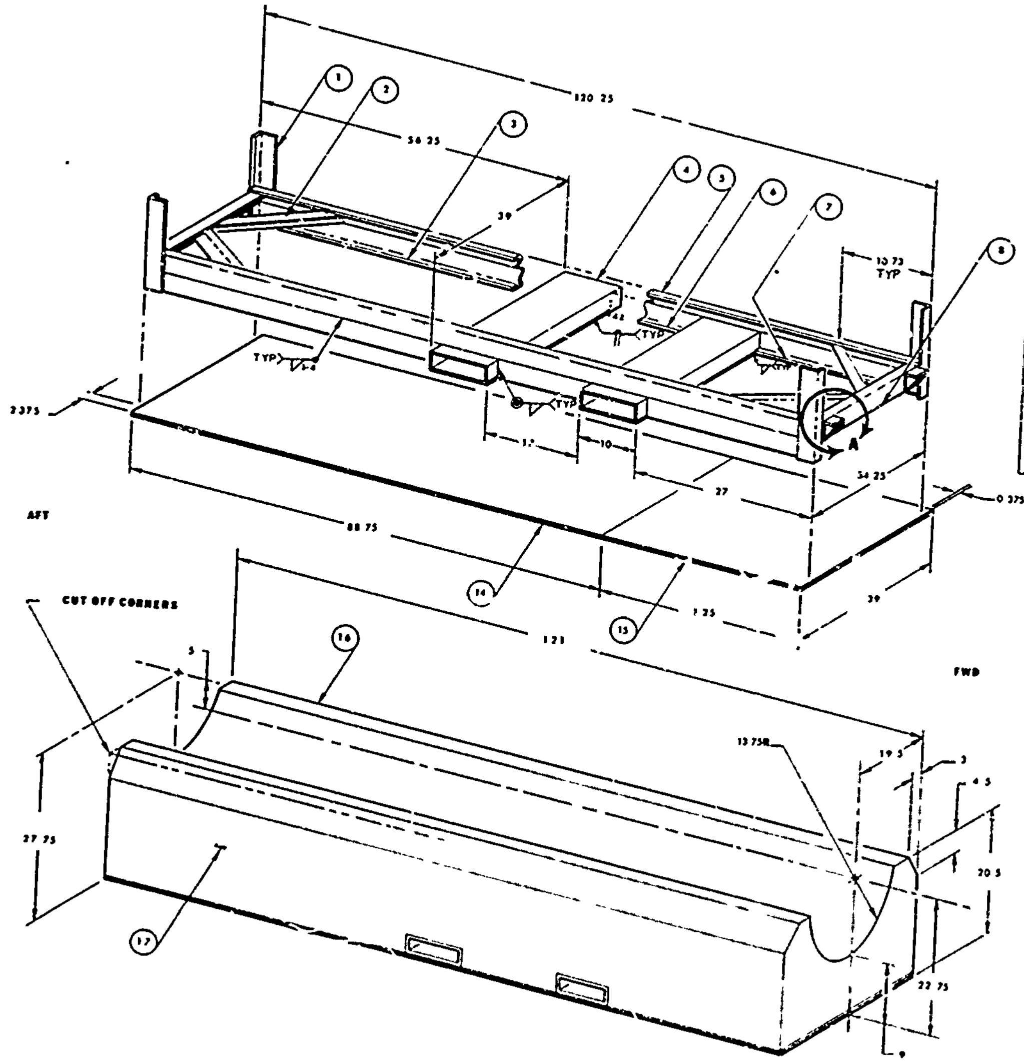
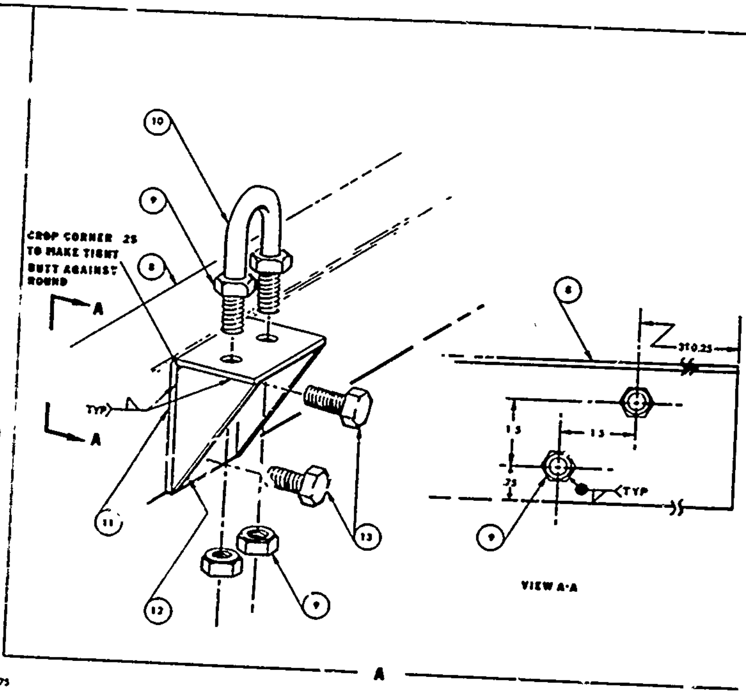


Figure 2. Total Encapsulation Concept





REF	QTY	DESCRIPTION	SIZE	MATERIAL
1	4	UPRIGHTS	16 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
2	4	DIAGONALS	15 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
3	2	LOWER AFT SIDE MEMBERS	56 1/8 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
4	2	FORKLIFT OPENINGS	39 x 26 OD x 14 GA	STEEL
5	2	TOP SIDE MEMBERS	120 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
6	2	LOWER CENTER SIDE MEMBERS	17 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
7	2	LOWER FWD SIDE MEMBERS	27 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
8	2	END MEMBERS	34 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
9	A/R	REG SEMIFIN HEX NUT	5/16-18 UNC 2B	
10	4	3/4 U BOLT	5/16-18 UNC 2A x 3/8 THREADED	
11	4	BRACKETS	3 x 3 1/8 x 1 5/8	12 GA. SLOTTED ANGLE
12	8	GUSSETS	3 x 1 1/2 x 14 EA.	STEEL
13	A/R	REG SEMIFIN HEX BOLT	5/16-18 UNC 2A x 3/4	
14	1	WOOD BASE	88.75 x 39 x 0.5	PLYWOOD, EXTERIOR
15	1	WOOD BASE	32.25 x 39 x 0.5	PLYWOOD, EXTERIOR
16	1	2 LB PCF RIGID POLYURETHANE FOAM	121 x 39 x 22	12.5 GAL A / 12.5 GAL B 2 LBS RIGID
17	1 GAL	PAINT	N/A	ALIPHATIC POLYURETHANE (MIL-C-83286) OR ALUMINIZED ENAMEL

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FOAM CONTAINER FOR HH-53 HELICOPTERS
450 GAL EXT FUEL TANKS

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Figure 3

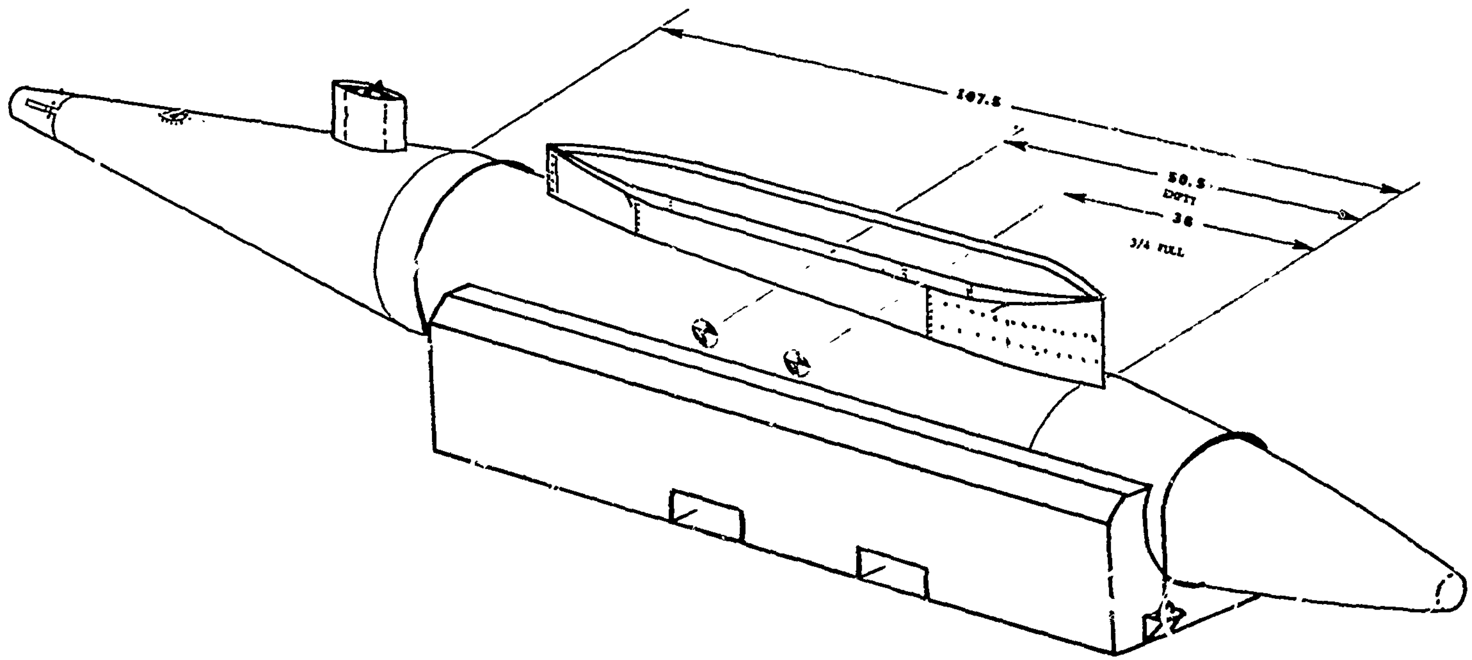
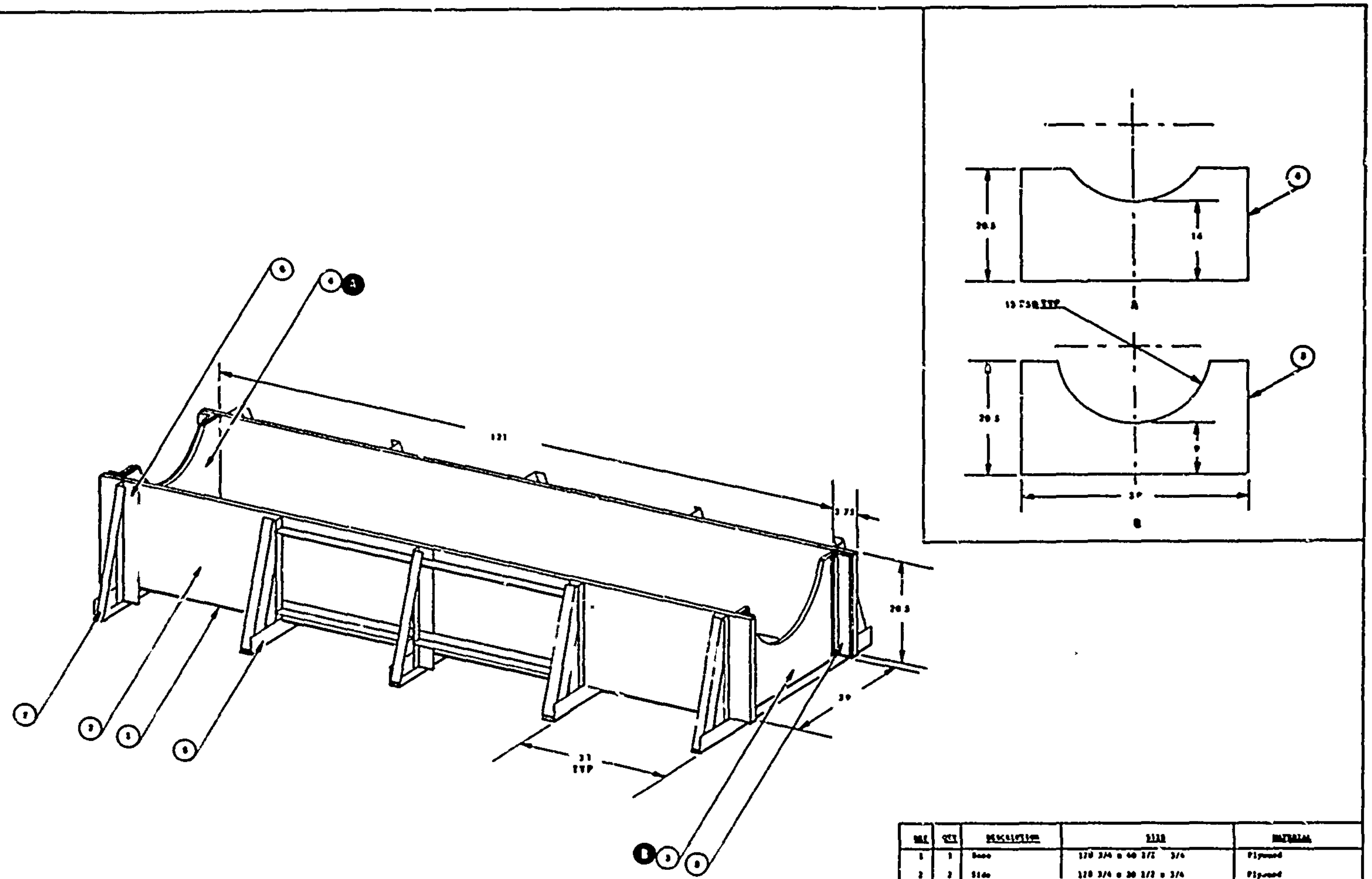


Figure 4. Final Prototype Design



FORMING JIG

NO.	QTY	DESCRIPTION	SIZE	MATERIAL
1	1	Base	120 3/4 x 40 1/2 3/4	Plywood
2	2	Side	120 3/4 x 20 1/2 x 3/4	Plywood
3	1	Forward End	30 x 20 1/2 x 3/4	Plywood
4	1	Aft End	30 x 20 1/2 x 3/4	Plywood
5	5	Support, Base	64 1/2 x 3 1/8 x 1 5/8	12 Ga Slotted Angle
6	10	Support, Upright	25 1/8 x 3 1/8 x 1 5/8	12 Ga Slotted Angle
7	10	Support, Diagonal	20 1/8 (approx) x 3 1/8 x 1 5/8	12 Ga Slotted Angle
8	4	Support, Saddle	20 1/2 x 3 1/8 x 1 5/8	12 Ga Slotted Angle

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FOAM CONTAINER FOR HH-53 HELICOPTERS
450 GAL EXT FUEL TANKS

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SHEET 2 OF 2

Figure 5

ASSEMBLY PROCEDURE: H-53, 450-GALLON EXTERNAL FUEL TANK HANDLING DEVICE

1. Assemble forming jig as shown in sheet 2 of Drawing No. X 7656250.

2. Either coat the jig interior with a foam release agent or cover the interior floor, sides, and ends with 2.0 mil polyethylene film, making sure there will be no places that foam will leak through.

3. Assemble the slotted angle internal structure as shown in sheet 1 of Drawing No. X 7656250. At this point, the brackets are assembled as shown in A, and fitted to the end members (#8). The nuts (#9) that hold each bracket to the end member are welded into position at this time.

4. Remove the bracket assemblies prior to the foaming operation. They will be replaced in the final assembly.

5. Place the plywood base (#14 and #15) in the forming jig. Center the internal structure assembly on this base. Make sure the center of the fork lift openings is forward of the center of the foaming jig.

6. Position the H-53, 450-gallon external fuel tank in the forming jig in a nose down configuration.

7. Coat/Cover the fuel tank bottom with a foam release agent or polyethylene film to a point approximately 3" above the horizontal centerline.

8. Pour the foam-in-place (#16) into the forming jig cavity, making sure to evenly distribute the foam. (Approximately 64 cu ft of foam will be used.)

9. Allow the rigid foam to cure for at least one hour.

10. Remove fuel tank, release agent or polyethylene film and completed foam body.

11. Shape the foam with a hacksaw blade or equal to get desired shape.

12. Spray paint (#17) entire handling device/container.

13. Install bracket assemblies.

14. Mark container as required.

Figure 6

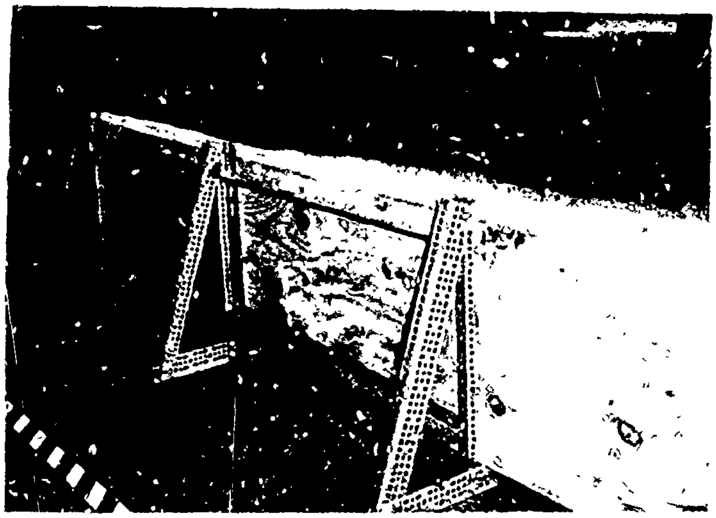

Figure 7. Forming Jig, Side View

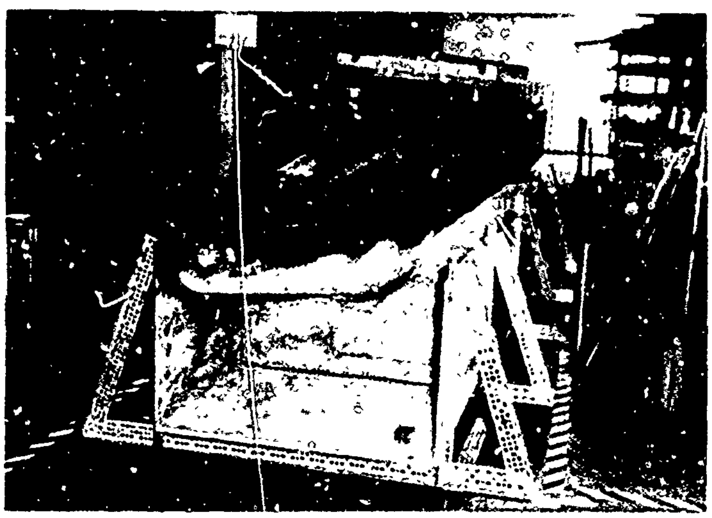

Figure 8. Forming Jig, End View

Figure 9. Final Prototype, End View

Figure 10. Final Prototype, Side View